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ABSTRACT

A study was conducted to determine if there was a relationship between the cognitive styles of learners and their ability to correctly identify previously seen pictorial materials presented in color or black and white. Fifty-three third and fourth grade students from the Pittsburgh Public School System served as subjects for the study. Testing instruments were used to determine the degree to which the children exhibited two cognitive styles, field dependence-independence and reflectivity-impulsivity. The stimulus materials for the recognition task consisted of a set of 400 slides of natural objects and scenes, half of which were in color and half of which were in black and white. The study tentatively concluded that the addition of color is a significant factor in a pictorial recognition memory task and may aid individuals along the entire continuum of field dependence-independence; however, it was also concluded that an interaction did not exist between the color mode and reflectivity-impulsivity. (Author/LLS)

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THE INTERACTIVE EFFECTS OF COLOR AND COGNITIVE STYLE ON A PICTORIAL RECOGNITION MEMORY TASK

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In past years media research has often been evaluative in nature, comparing learning from one medium with learning from another. During the last decade this type of comparative research has often been criticized because of its failure to produce useful research questions, significant findings, or a theory of instruction. Many have hypothesized that the problem may lie in the failure to conduct research that goes beyond the descriptive stage and into the prescriptive stage (Allen, 1971; Salomon and Clark, 1977). Some suggest that media must be defined in terms of unique attributes which fulfill unique psychological functions (Salomon, 1971). The cognitive and non-cognitive characteristics of the individual, the ultimate learning task, and the best method of achieving this goal all interact to produce the desired result. Aptitude-treatment interaction research is beginning to provide specific guidelines that may establish principles of instructional design which consider these three elements. But a need still exists to go beyond defining interactions in terms of the general intellectual abilities of individuals and the broad levels of learning or of instructional events. It is to meet this need that this particular study was designed.

The elements investigated in the study were chosen to answer the demand for specificity in the media, learner and task variables. Much comparative research has been conducted examining the usefulness of color in facilitating learning. The investigations have often produced conflicting evidence. VanderMeer (1954) found that students preferred color films to black and white films, but there was no correlation between preference and learning in immediate verbal posttests. Fullerton (1956) and Kanner and Rosenstein (1960)

found similar results. More recent research conducted by Dwyer (1971) and Berry (1974) has found that color is a significant design factor. When the results of these studies are taken into consideration, it seems apparent that as Otto and Askov (1968) indicated the "cue value of color in learning is still essentially unclear" (p. 161).

One variable that may be interacting with color to produce these inconclusive results is that of cognitive style. This learner characteristic involves the unique ways the individual perceives his environment. The two specific styles of field dependence-independence and reflectivity-impulsivity are illustrative of those being researched in relationship to the perceptual area of cognition. Each of these represents a different aspect of stimulus reception capabilities in the learner and thus relates to variations in display characteristics, particularly in visual presentations.

The question now apparent is how do these two cognitive styles interact with color in achieving a specific learning task. The task variable chosen to examine this relationship is that of pictorial recognition memory. It is one of the most basic types of learning involving visual perception, yet one that is not entirely understood. Research in the area of visual learning has indicated that pictures are remembered better than either words or sentences (Shepard, 1967; Standing, 1973). This finding applies to such fundamental tasks as simple visual recognition as well as to more advanced types of learning, such as concept attainment and principle development (Gropper, 1966). Many of the characteristics which facilitate or hinder visual recognition or concept attainment, however, are yet to be investigated.

These three variables coalesce and form a sound rationale for assuming the existence of a reliable interaction, for the learning task involves a visual presentation which must be perceived, encoded, and retrieved, a function of cognitive style, and the display characteristic of color may determine how successfully this is accomplished. Thus the purpose of the study evolved into an investigation of the interaction of field dependence-independence and reflectivity-impulsivity, both individually and simultaneously, with color cueing, and pictorial recognition memory in elementary school children.

Following the principles of aptitude-treatment interaction research which involve task, learner, and treatment analysis to determine potential interactions (Cranbach and Snow, 1977) the following research questions were formulated:

1. Is there a significant interaction between the presence or absence of color in a pictorial presentation and the cognitive style variable of field dependence-independence?
2. Is there a significant interaction between the presence or absence of color in a pictorial presentation and the cognitive style variable of reflectivity-impulsivity?
3. Is there a significant interaction between the presence or absence of color in a pictorial presentation and the cognitive style variables of reflectivity-impulsivity and field dependence-independence when considered simultaneously within the individual?

Related Research

Research in each of the variables under investigation, that of cognitive style, particularly field dependence-independence, and reflectivity-impulsivity, pictorial recognition memory, and color in visualized learning has been conducted with each element being considered independently. Limited work has been done in interrelating cognitive style and color cueing and none in which a dual cognitive style component in each subject was studied in relationship to a learning task.

Research in the area of cognitive styles has indicated that these are "individual variations in modes of perceiving, remembering, and thinking, or as distinctive ways of apprehending, storing, transforming, and utilizing information" (Kogan, 1971, p. 224). Witkin, Moore, Goodenough, and Cox (1977), basing their conclusions on research in the area of field dependence-independence, have enumerated the essential characteristics of cognitive styles. First, cognitive styles are concerned with the form rather than the content of cognitive ability. They refer to how individuals differ in what is perceived, thought, learned, or resolved not to how much is perceived or learned. Second, cognitive styles are pervasive dimensions and are not only a part of cognition but also of personality. A third characteristic is that of stability over time. A person who has a particular style one day will have the same style the next day, month or year. Related to this stability is the apparent general resistance of certain styles to training or change. Fourth, with regard to value judgments, cognitive styles are bipolar. Each pole has certain characteristics which are valuable in meeting

the needs of a particular situation. Because of these characteristics cognitive styles are influential during all learning and thus should be considered when planning instructional situations and materials.

Two particular cognitive styles, those of field dependence-independence and reflectivity-impulsivity are evident in visual perception and thus function in situations involving learning from pictures.

Field dependence-independence concerns the ability to perceive details as discrete from their backgrounds and to overcome an embedding context (Witkin, Dyk, Faterson, Goodenough, Karp, 1974). An example of such a task is the Embedded Figures Test (EFT) (Witkin, 1971) in which the subject is shown a simple figure and then required to find it in a complex design which is so patterned that each component of the simple figure is made part of a clear-cut sub-whole of the pattern. The simple figure is thereby effectively "hidden". The person who experiences in a field independent fashion has the ability to perceive items as discrete from their background and to reorganize a field when the field is organized. The field independent individual is also able to impose structure on a field and so perceive it as organized when the field has relatively little inherent structure. Field dependent individuals are less likely to attempt to structure or restructure stimuli, thus they usually experience ambiguous stimuli as vague and undefined.

The cognitive style of the reflectivity-impulsivity also has direct implications in the area of visual perception. It involves the individual's evaluation of his own cognitive products--that is, his willingness to pause and reflect on the accuracy of his responses. Some individuals act upon the first solution that enters their mind, paying little attention to its appropriateness or validity. These individuals are classified as impulsive. Other individuals, the reflectives, devote considerable time to reflection before opting for a specific alternative in a situation of response uncertainty (Kagan, Rosman, Day, Albert, Phillips, 1964). The test designed to indicate this perceptual style, the Matching Familiar Figures Test (MFFT) (Kagan, 1969), requires discrimination of visual detail presented via pictorial stimuli. Each item on the test consists of a standard and six alternatives, one of which is identical to the standard. The individual is asked to select the matching alternative. The subjects who respond quickly often err (impulsives), whereas those who pause to reflect on response alternatives are more often correct (reflectives).

Research conducted to study antecedents of the dimension have centered on scanning techniques and attention deployment. Siegel, Kirasic, and Kilburg (1973) indicated that on tasks highly correlated with the MFFT, both reflective and impulsive children utilize feature differences in a problem solution, but reflective children tend to perform a more thorough and detailed feature analysis of the stimulus array. Drake (1970) further concluded that the impulsive child simply searches for a variant that globally resembles the standard and is not very discriminating

or particular in his viewing. Impulsive subjects do not scan all of the alternatives in the MFFT before venturing a solution, whereas reflective children make careful visual searches of the standard and all of the variants before they are willing to offer a response. This complete search made by reflective individuals makes possible better identification of the variants and successful encoding of these variants for storage and subsequent comparison with the stimulus.

One of the most basic types of learning that involves visual perception and thus may be influenced by these two styles is that of pictorial recognition memory. It has been defined as the ability to perceive, encode, store, and retrieve visual information (Standing, Conezio, and Haber, 1970). Cognitive styles have also been defined as "distinctive ways of...storing...and utilizing information" (Kogan, 1971, p. 244). It, therefore, appears that the two variables in learning are closely related. Research in this area has begun to investigate this relationship with varying results. Myatt (1974) concluded that cognitive style as measured by the EFT did not appear to be a factor in pictorial recognition memory. Rudnick (1974), who conducted an experiment involving auditory masking, color, and perceptual style, found, however, that field independent individuals recognized significantly more pictures than did field dependent subjects.

In an experiment conducted by Siegel (Siegel, et al., 1973) preschool children grouped as reflective or impulsive were found to differ significantly in a forced-choice recognition memory task. Reflective preschool children made more correct recognition choices

than did impulsive children when correct responses could be made on the basis of verbal labels, visual feature analysis, or both. This finding seems to indicate that detailed visual feature analysis is a significant component of reflectivity-impulsivity.

An element which may be interacting with cognitive style to produce these results is color. A number of studies have been conducted to investigate the interrelationship of these two variables. Rudnick (1974), while researching visual recognition and recall in children categorized as field independent, moderately field independent and field dependent, found that in all groups color visuals were recognized to a significantly greater degree than black and white visuals. Myatt (1974), however, concluded that color was not a significant factor in pictorial recognition in children and adults similarly grouped. Chan (1974), investigating color mode and reflectivity-impulsivity found that color stimuli on the MFFT facilitated learning when the intra-array similarity of each visual presentation was high. The implications appear to be that the greater the similarity among variants in the visual array, the more effectively color stimuli function as facilitators of matching.

In situations where color cueing appears to be significant, a number of reasons have been suggested to explain this superiority. Dale (1969) theorizes that color in a visual presentation can perform three major tasks: 1. It can heighten realism; 2. It can distinguish and emphasize detail or contrast; 3. It can produce esthetic effects. In the case of an impulsive individual, the added realism and the esthetic effects produced by using color may increase the time spent scanning a visual thus allowing more of the

stimulus variables to be encoded for later retrieval. The use of color to provide contrast may aid the field dependent individual to disembed the figure from the ground more easily thus allowing more information to be stored in memory.

There is also evidence that children who are classified as impulsive do not encode all stimulus information and thus respond to color more than reflective children (Katz, 1971). Rudnick (1974) speculated that differences in subjects' scores on recognition of color and monchrome photographs may be due to a loss of detail in the monochrome photographs. This lack of detail may explain why field dependent subjects and impulsive subjects do not perform as well as their counterparts on recognition memory tests. The field dependent subjects may need the extra detail in order to disembed information found in visuals from its background. The impulsive individual, since he does not scan as broadly and as systematically, may need the detail as an added cue for encoding and retrieval.

In summary, limited work has been done in interrelating cognitive style and color cueing and none in which a dual cognitive style component in each subject was investigated. Yet research in the use of color in visual presentations has often produced conflicting results. A factor that may be contributing to this situation is that of cognitive style. Careful task analysis indicates that the components of a pictorial recognition memory task include the ability to visually discriminate and separate details of a picture from their background and to analyze the stimulus array for encoding purposes so that a recognition decision

can be made at a later time. An examination of learner characteristics or aptitudes suggests that the cognitive styles of field dependence-independence and reflectivity-impulsivity may function in such a task.

The media attribute of color can be hypothesized as an interacting variable. Because of the added realism and the esthetic effects produced by the use of color, it can be assumed that impulsive individuals will spend more time scanning a visual, thus allowing more of the stimulus variables to be encoded and eventually retrieved. The use of color can also result in increased time spent in scanning the response alternatives presented during the recognition test. This can result in a more accurate response and a higher recognition rate. The addition of color also results in added detail which can aid the impulsive individual in retrieval by providing more visual cues for encoding. Thus, the realism, the esthetic effects, and the added detail resulting from the use of color can compensate for the impulsive individual's tendency to scan visuals quickly and unsystematically.

The addition of color can also aid the field dependent individual in a pictorial recognition memory task. The ability of color to distinguish and emphasize detail or contrast will enable the field dependent individual to disembed the figure from the ground more readily, therefore allowing more information to be stored in memory. Thus, color may compensate for the inability of field dependent individuals to perceive figure from ground by providing visual cues that may make the completion of this task possible.

Methodology

The primary purpose of the study was to investigate the relationship between the cognitive styles of learners and their ability to correctly identify previously seen pictorial materials presented in color or black and white. The statistical model chosen to analyze the various interactions was that of regression analysis. The following null hypotheses can, therefore, be formulated.

Ho: 1. There is no significant difference between the slopes of lines used to predict performance on a color or black and white memory task from field dependence-independence scores.

Ho: 2. There is no significant difference between slopes of the lines used to predict performance on a color or black and white memory task from reflectivity-impulsivity scores.

Ho: 3. There is no significant difference between the slopes of the planes used to predict performance on a color or black and white memory task from scores of field dependence-independence and reflectivity-impulsivity when considered simultaneously.

The subjects for this study were 53 third and fourth grade students from the Pittsburgh Public School System. The children were from middle class socio-economic backgrounds with I.Q.'s falling into the average or above range as measured by the Otis-Lennon Mental Ability Test given in the second grade. None were found to be color blind when given the Ishihara Color Vision Test.

The testing instruments which were used to determine the two cognitive styles under consideration were the Children's Embedded Figures Test (CEFT) (Karp and Konstadt, 1971) and the Matching Familiar Figures Test (MFFT) (Kagan, 1969). The CEFT is an individually administered test determining the degree of field dependence-independence in children. This instrument has no specific time limit and the total score is equal to the number of items identified. Twenty-five is the maximum score which indicates a large degree of field independence.

The studies conducted to determine the reliability and validity of the CEFT indicate that it is both a valid and reliable instrument for determining field dependence-independence in children 12 years of age and younger. The reliability coefficients for the age group under consideration, 9 to 10 years of age, are .89 for males, .89 for females and .88 for the group as a whole. Validity coefficients indicate that for ages 9 and 10 the coefficients are .70 for males, .73 for females, and .71 for the standardizing group in general (Witkin, et al., 1971).

The MFFT is also an individually administered test which determines the degree of reflectivity-impulsivity. It is a timed test with a dual score consisting of response latency to first response and number of errors for each of the twelve test items. Children above the group median in response latency and below the group median in error frequency are considered to be reflective. Children below the group median in response latency and above the group median in error rate are considered to be impulsive.

Reliability coefficients, obtained by Egeland (1974) using equivalent forms of the same test for adults and children, ranged from .92 to .98 but whether these figures applied to response latency, errors, or both was not indicated.

The stimulus materials for the recognition task consisted of a set of 400 color slides of natural objects and scenes. Slides with any verbal material, recognizable human figures or unique features were eliminated. This group of 400 slides was randomly divided into halves. One half, or 200 slides, were photographically recopied into black and white using a Honeywell Repronar Slide-Duplicator, Kodak Panatomic X film, and Kodak Direct Positive Processing Chemistry. The remaining 200 slides were retained in color. Each group of 200 slides was randomly divided in half a second time. One half, or 100 slides in each color mode, were designated the learning or stimulus slides and the other 100 in each group were designated the distractor slides. The learning slides were duplicated and randomly combined with the distractor slides to form the recognition set.

The 53 subjects were individually administered the CEFT and the MFFT during two separate testing sessions one month apart. Since the "scores from any test of field dependence form a continuous variable" (Witkin, et al., 1971, p. 4) the subjects were not dichotomously grouped as field dependent-independent as in previous studies. Each subject was given a score on a continuous scale ranging from 0 to 25, with 0 indicating extreme field dependence and 25 extreme field independence. In this way all the subjects,

not just the highest and lowest 1/3 or 1/4 of the group, were studied and vital information was gained concerning individuals who are not dominantly field dependent or field independent and who have long been neglected in experimental research.

The MFFT has also been criticized for artificially dichotomizing the continuous variable of reflectivity-impulsivity thus squandering potentially valuable discrimination information (Kerlinger and Pedhauser, 1973). For this reason the subjects in this study were given a dual score consisting of response latency and error rate, but were not grouped as reflective or impulsive. The dual score was then converted into a ratio score of response errors over response latency. Thus an individual with a response error score of 10 and a response latency score of 100 would have a ratio score of .1. Individuals who tended to be reflective would have smaller ratio scores.

Four to six weeks after the completion of the testing sessions to determine cognitive style, the first session involving the recognition task took place. All subjects were shown 100 stimulus slides, 50 black and white slides and 50 color slides randomly chosen from the original set of stimulus slides. This was followed by the recognition set of 200 slides evenly divided between both color modes. These included the 100 stimulus slides just seen and 100 distractor slides. At a second testing session, one month later, a similar procedure was followed using the remaining 100 stimulus slides and 100 distractor slides.

The "forced-choice" procedure for recognition experiments was followed. In this method a recognition set consists of an old stimulus item presented simultaneously with one or more new or distractor items. The subject must discriminate the old item from the new ones (Adams, 1976). In this study the subjects were shown the stimulus item and one distractor item.

Each subject was shown the group of 100 randomly sorted stimulus slides each for an interval of 2 seconds. After the first 50 stimulus slides had been viewed a 5 minute rest period was given before the recognition set of slides was shown. On each recognition item two slides were presented side by side, one a randomly selected copy of a stimulus slide and the other a randomly chosen distractor slide both of the same mode, color or black and white. The slides were randomly placed in a right or left hand position on the screen and labeled A or B. Each subject was instructed to state whether slide A or slide B had been seen before. Each recognition item was presented for an interval of 8 seconds. A 3 minute rest period was given after the first 50 test items. One month later the subjects were shown the second group of stimulus and recognition slides. The same procedure was followed on this occasion.

Results

Ho: 1. There is no significant difference between the slopes of the lines used to predict performance on a color or black and white memory task from field dependence-independence scores.

This hypothesis was tested by means of a linear regression analysis. The intercepts and the slopes for each regression equation are reported in Table 1.

Table 1

Linear Regression Equations - CEFT

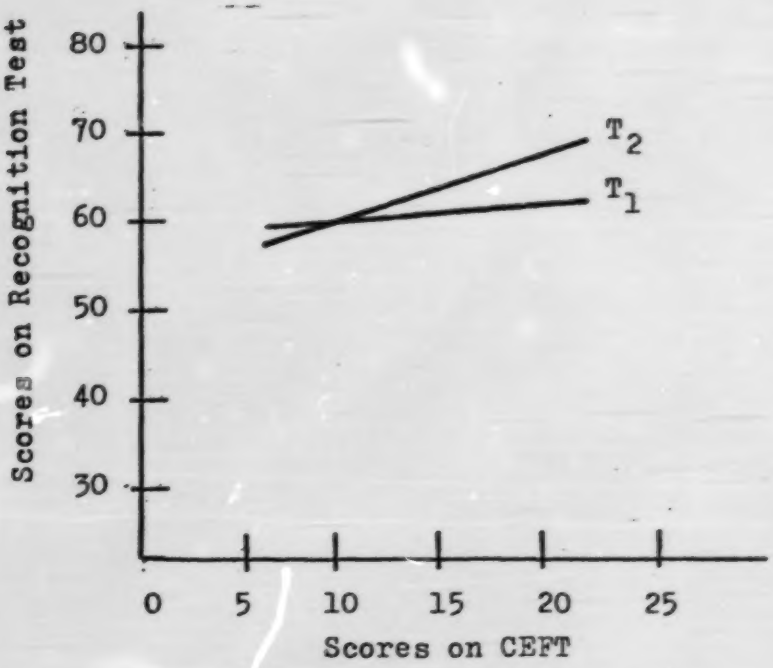
Treatment	Intercept	Slope
Color	53.367	.722
Black and White	58.221	.169

The slopes for the two regression lines were tested by an F statistic and found to be significant. ($F = 9.071$; $df = 1/51$; $p < .01$). Therefore, Hypothesis 1 was rejected. The slopes of the prediction lines for field dependence-independence and the two treatment modes were not equal. Thus an interaction existed between the aptitude variable of field dependence-independence and the design element of color.

The regression lines were then plotted to determine the type of interaction that existed, i.e., ordinal or disordinal. The results of this operation are shown in Figure 1.

As seen in Figure 1 a disordinal interaction existed with regression lines for color and black and white intersecting within the range of the aptitude variable in question. In this case the intersection point was approximately 9. Such findings imply, in general, that assigning subjects on opposite sides of the intersection to alternative treatments would be instructionally sound. Thus, subjects to the right of the point of intersection would be expected to benefit more from the color treatment than from the black and white treatment, while those to the left of the point of

Figure 1. Regression Lines for CEFT and Treatment Mode



T_1 - Black and White

T_2 - Color

intersection would probably benefit more from the black and white treatment than from the color treatment. In the present study the color treatment was superior to the black and white treatment through most of the aptitude range. There were only 4 individuals for whom the black and white treatment was the superior treatment.

Ho: 2. There is no significant difference between the slopes of the lines used to predict performance on a color or black and white memory task from reflectivity-impulsivity scores.

This hypothesis was also tested by means of a linear regression analysis. The intercepts and the slopes for each regression equation are reported in Table 2.

Table 2

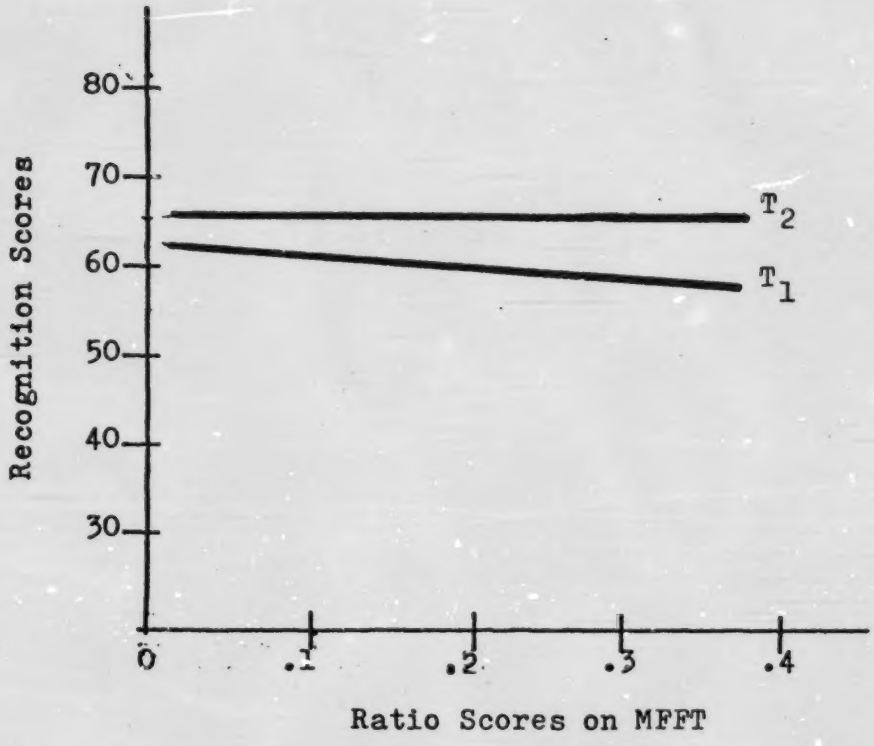
Linear Regression Equations - MFFT

Treatment	Intercept	Slope
Color	65.287	-8.923
Black and White	62.642	-28.436

The slopes for the two regression lines were tested by an F statistic and found not to be significant ($F = 1.795$; $df = 1/51$; $p < .01$). Therefore, Hypothesis 2 was retained. The slopes of the prediction lines for reflectivity-impulsivity and the two color modes were not significantly different. Thus, an interaction did not exist between the aptitude variable of reflectivity-impulsivity and the design element of color.

Even though no interaction existed between the two variables the regression lines were plotted in order to provide information leading to the generation of new hypotheses. The results of this operation are shown in Figure 2.

Figure 2. Regression Lines for MFFT and Treatment Mode



T_1 - Black and White

T_2 - Color

As seen in Figure 2, the two lines did not intersect within the range of the aptitude variable. This indicated that when the cognitive style variable of reflectivity-impulsivity is considered it makes no difference whether the visuals in a pictorial recognition memory task are presented in color or in black and white.

Ho: 3. There is no significant difference between the slopes of the planes used to predict performance on color or black and white memory task from scores of field dependence-independence and reflectivity-impulsivity when considered simultaneously.

The hypothesis was tested by means of a multivariate multiple regression analysis. The intercept and the slopes for each regression plane are reported in Table 3.

Table 3

Multivariate Multiple Regression Equations

Treatment	Intercept	CEFT Coefficient	MFFT Coefficient
Color	53.857	.718	-7.095
Black and White	60.155	.156	-28.038

The slopes for the two regression planes were then tested by an F statistic and found to be significant ($F = 5.869$; df - 2/50; $p < .05$). Therefore, Hypothesis 3 was rejected. The slopes of the prediction planes for field dependence-independence, reflectivity-impulsivity, and treatment modes were not equal. An interaction did exist between the two aptitude variables and the two treatment modes when considered simultaneously.

Two univariate tests were then done to determine which of the two independent variables was responsible for the interaction. The equality of the slopes for field dependence-independence and color and black and white, given that the variable reflectivity-impulsivity was also in the equation, was tested by an F statistic. The same procedure was also followed to test the equality of the slopes for reflectivity-impulsivity given that the variable field dependence-independence was also in the equation.

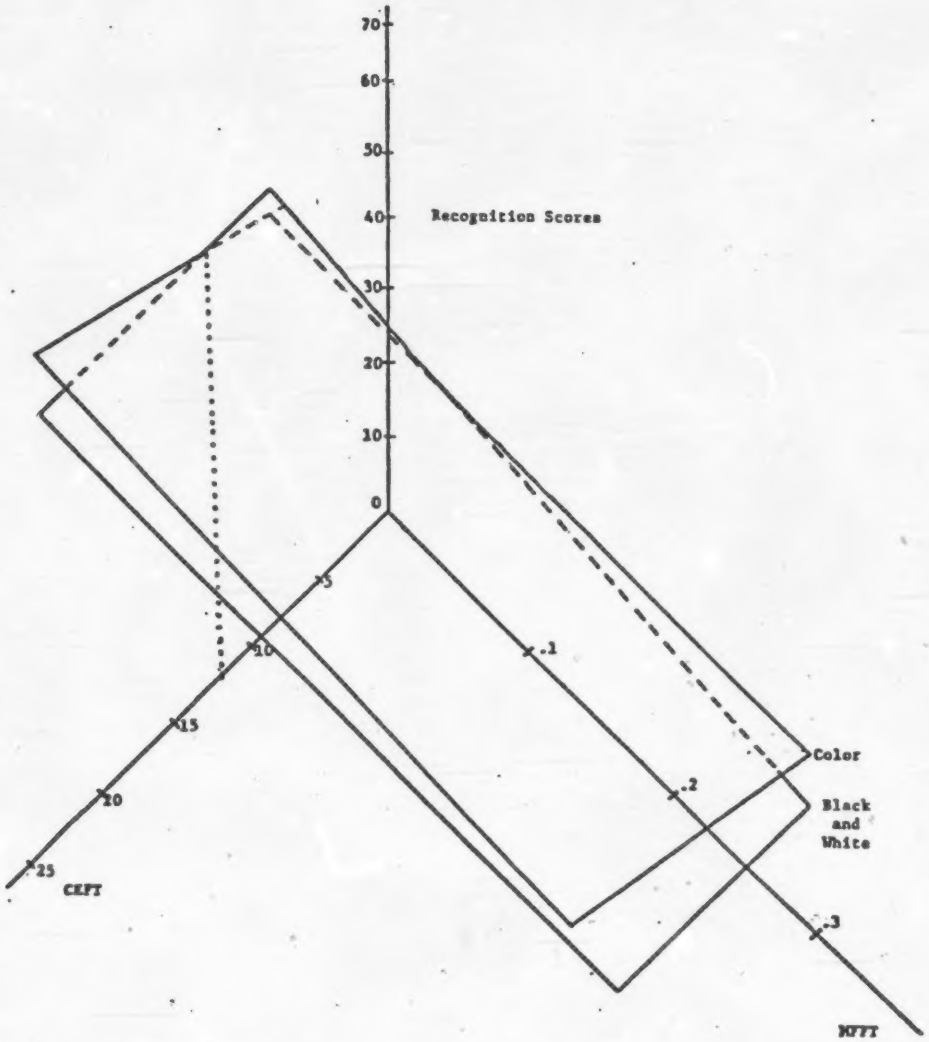
The results indicated that the interaction between the two aptitude variables and the two treatment variables was due to the presence of the field dependent-independent cognitive style. Reflectivity-impulsivity was not responsible for any of the interaction. The F value for field dependence-independence was 9.639 and for reflectivity-impulsivity 2.416.

These findings supported the results found in testing the two independent variables separately without regard for the presence of the other variable. In that case, a significant interaction was present for field dependence-independence and treatment mode as was the case when the two independent variables were considered simultaneously. Again reflectivity-impulsivity produced no interaction when considered independently or in conjunction with field dependence-independence.

The regression planes were then plotted to determine whether an ordinal or disordinal interaction existed. The results of this operation are shown in Figure 3.

As seen in Figure 3, a disordinal interaction existed with regression planes for color and for black and white intersecting within the range of the aptitude variables in question. Although both planes intersected a valid prediction line could not be drawn between the points of intersection because one interaction, that of MFFT, was not statistically significant. The point of intersection on the CEFT variable, however, was projected onto the CEFT axis. Subjects with scores below the intersection point on this axis benefited more from the use of the black and white treatment.

Figure 3. Regression Planes for MFFT, CEFT, and Treatment Mode



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It must be pointed out, however, that in the case of reflectivity-impulsivity, either treatment was valid because a significant interaction did not exist between this variable and the treatment.

Discussion

The findings of the study indicated that since the slopes of the prediction lines for field dependence-independence and treatment mode were not equal a significant interaction did exist, in this case, a disordinal interaction. The point of intersection was a score of approximately 9 on the CEFT. Theoretically, all individuals to the right of the point of intersection, those with scores higher than 9, would benefit more from the color treatment, whereas those to the left of the point of intersection, those with scores less than 9, would benefit more from the black and white treatment.

Practically speaking, in the present study, only four individuals scored lower than 9 on the CEFT and at the present time statistical analysis capable of determining a justifiable decision rule for classification of individuals into treatment does not exist when one group has been given both treatments. It was possible, therefore, to determine that a significant interaction existed, but impossible to determine the points before and after the point of intersection where placement in one treatment or another would make a significant difference.

Since so few individuals scored below the point of intersection it can tentatively be concluded that the addition of color is a significant factor in a pictorial recognition memory task and may aid individuals along the entire continuum of field dependence-independence. This conclusion finds support in research done by Rudnick (1974) and Berry (1977), both of whom found color to be a significant variable in recognition memory. For the more field dependent individuals color may perform the task requirement of visual discrimination and separation--a process they are not able to accomplish themselves. For the more field independent individuals color may emphasize detail and contrast and enable these individuals to utilize more completely their ability to disembed figure from ground.

In order to test this conclusion it would be necessary to conduct research on groups of individuals that were given one treatment or the other so that a decision rule could be determined that would indicate at what points a significant difference would result if individuals were assigned to one treatment or another. It may be found that the significant cut off point for black and white does not lie within the range of the variable under consideration. At that time justification can be given for the use of color at any point on the scale of field dependence-independence.

It was also found that since the slopes of the predictions lines for reflectivity-impulsivity and color mode were not significantly different, an interaction did not exist. It is to be noted, however, that in all cases, color recognition scores were higher than those for black and white. The present results were somewhat

unexpected because of the recent research by Katz (1971, 1972) and Chan (1974). Katz indicated that impulsive children respond to color more than reflective children, and in color-form sorting tasks impulsive children use color more often than do reflective children to accomplish the task. The results of the Chan study also indicated that on the MFFT, color stimuli facilitated learning when the intra-array similarity of each visual presentation was high.

In attempting to explain the lack of an interaction between this cognitive style and the treatment modes, a number of theories may be postulated. The first may be explained by reference to the two-stage model of selective attention suggested by Hagen (1972). The first stage is one of discrimination where the subject identifies both the relevant and incidental cues. The second stage involves focusing on the relevant features and ignoring the incidental cues. Impulsive children may have trouble attending selectively because of problems in stage 1 related to difficulty in distinguishing relevant from irrelevant cues. Since impulsive children are less analytic than reflective children and do better when required to perceive wholes rather than details, the addition of color may have resulted in the impulsive child being able to encode more visual cues. These children, however, may not be able to separate relevant from irrelevant cues and thus remember more pictures.

Another theory that can be considered centers around the area of response latency. Research by Fleming and Sheikhian (1972) has shown that presentation times of two seconds or less may be inadequate for processing the quantity of information available in

pictures. In addition, Dwyer (1972) speculates that in fixed-pace presentations learners do not have time to take advantage of the added information available in realistic visuals, of which color is an example. In the present study the presentation time of 2 seconds may not have allowed the subjects to respond to the presence or absence of color in the visuals. In order to test this hypothesis it would be necessary to conduct a study which is self-paced, allowing learners to take as much time as necessary to scan each of the visuals. Since pictorial recognition is very high a ceiling effect can be avoided by increasing the similarity of each of the visuals.

Finally it was found that since the slopes for the prediction planes for both field dependence-independence and reflectivity-impulsivity, when tested simultaneously, were not equal an interaction existed, in this case a disordinal interaction. The results of further analysis indicated that the interaction between the bivariate aptitude and the two treatments was due to the presence of the field dependent-independent cognitive style. The point of interaction on the CEFT variable was projected onto the CEFT axis and was determined to be approximately 12. This intersection point differs from the previous one because the variable reflectivity-impulsivity was also in the regression equation. Thus, individuals with scores lower than 12 on the CEFT benefited more from a black and white treatment, whereas, individuals with scores higher than 12 benefited more from a color treatment.

It is interesting to note that even when the two cognitive styles are considered simultaneously, the interaction between treatment mode and cognitive style still raises the question as to

whether color might not be effective for individuals along the entire continuum of field dependence-independence. Further research is again needed to clarify this issue. At the present time the color cueing appears to follow a perferential function. The addition of color to the visuals seemed to emphasize detail and contrast, thus enabling more field independent individuals to more fully utilize their ability to disembed figure from ground. The black and white color mode seemed to aid the more field dependent individuals by providing less visual cues and enabling them to encode and retrieve only those that were relevant. Knowlton's (1964) conclusion that realistic pictures, of which color is an element, are often too rich in detail and may act to reduce fidelity of communication by providing the viewer with cues that are irrelevant, may lend credence to this theory. Following Broadbent's (1958) and Travers' (1970) information overload hypothesis, the additional color cues may have jammed the information processing system of the more field dependent individuals, thus preventing the successful encoding and eventual retrieval of the color visual. Since, however, the black and white visuals did not offer as much detail and contrast, they could be more globally viewed and jamming would not occur. Only further research in which one or the other treatment is given to two individual groups can substantiate or refute this theory.

Summary and Conclusions

The present study clearly indicated that an interaction existed between color mode and field dependence-independence in a pictorial recognition memory task. It also concluded that such an

interaction did not exist between color mode and reflectivity-impulsivity. When the two cognitive styles were considered simultaneously, an interaction was present, again caused by the variable of field dependence-independence. These results can offer a beginning for the construction of a matrix of learner characteristics, media attributes, and task variables. In this way media producers and educators would have clear cut guidelines for delineating the most effective media treatment to employ in order to optimize both instructional development and learning success. As the educational process moves towards the universal use of Individual Educational Prescriptions, a widely accepted practice in special education programs, these types of guidelines could prove to be invaluable. By determining each individual's cognitive profile the proper combination of media treatments can be prescribed so that a learning goal can be successfully achieved. Continuing research that clarifies the relationship of cognitive and non-cognitive variables with specific media attributes for specific learning goals will hopefully provide a widely accepted and utilized theory of instruction and a rebutal of the criticisms lodged against media research.

Recommendations for Further Research

In order to more fully understand the relationship of media design elements and cognitive styles, the following recommendations for further research are made:

1. This study should be replicated to confirm the present findings.

2. The present study should be replicated placing subjects in either of the two treatment groups. In this way a decision rule can be formulated that would indicate at what points a significant difference would result if individuals were assigned to one treatment or another.
3. Numerous cognitive styles have been identified, many of them related to visual perception. Research should be conducted to determine the interaction of these cognitive styles and color cueing.
4. The various cognitive styles related to visual perception should be investigated in relationship to other specific components of visuals i.e., realism, complexity, informational load, and non-realistic color.
5. The various cognitive styles and the various components of visuals should be investigated in relationship to different types of learning tasks, such as recall, rule learning, concept attainment and application.
6. This same type of interactive research must also be conducted to investigate the relationship of cognitive style and design elements with learning goals in the affective domain.
7. Conclusions in the present study were drawn concerning only a small portion of the population involved in learning tasks. Further research is needed to determine the interaction of cognitive style and design elements along a developmental scale.

8. The present study involved an investigation of immediate recall. Research should be conducted to determine the relationship of cognitive style and design elements using both immediate and delayed posttests.
9. The recognition task in the present study was externally paced. A similar investigation should be undertaken using a self-paced recognition task.
10. Research must also be conducted to determine the effects of intercultural differences on the interaction of cognitive styles and color cueing.

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